Temeprature-dependent Seeger's liquid drop energy for nuclei up to Z=118

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Seeger's semi-empirical mass formula is revisited for two of its constants (bulk constant $\alpha(0)$ and neutron-proton asymmetry constant a_a) readjusted to obtain the ground-state (g.s.) binding energies of nuclei within a precision of <1.5 MeV and for nuclei up to Z=118. The aim is to include the temperature T-dependence on experimental binding energies, and not to obtain the new parameter set of Seeger's liquid drop energy V_{LDM}. Our proceedure is to define the g.s. binding energy $B = V_{LDM} + \delta U$, as per Strutinsky renormalization procedure, and using the empirical shell corrections δU of Myers and Swiatecki, fit the constants of V_{LDM} to obtain the experimental binding energy B_{expt} or theoretically calculated B_{theo} if data were not available. The T-dependence of the constants of V_{LDM}, is introduced as per the work of Davidson *et al.*, where the pairing energy $\delta(T)$ is modified as per new calculations on compound nucleus decays. The newly fitted constants of V_{LDM} at T=0 are made available here for use of other workers interested in nuclear dynamics of hot and rotating nuclei.

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I. INTRODUCTION

Seeger's mass formula [1] was given in 1961, with its constants fitted to ground-state (g.s) binding energies of some 488 nuclei available at that time. The temperature T-dependence of these constants was later introduced by Davidson *et al.* [2] on the basis of thermodynamical considerations of the nucleus. These constants, however, need be fitted again since a large amount of data on experimental g.s. binding energies [3], and their theoretically calculated values [4] for, not-yet observed, neutron- and proton-rich nuclei have now become available. Furthermore, the T-dependence of the constants, in particular the pairing constant $\delta(T)$, need be looked in to because of their recent un-successful use in calculating the decay properties of some excited compound nuclear systems [5]-[7]. Note that our aim here is not to obtain a new set of constants for Seeger's mass formula, but simply to include the T-dependence on experimental binding energies B_{expt}. For this purpose, a readjustment of only two of the four constants, the bulk constant $\alpha(0)$ and the neutron-proton asymmetry constant a_a, are enough to obtain the B_{expt} within <1.5 MeV. A similar job was first done in [8] for nuclei up to Z=56, and then in [9] up to Z=97, but is redone here with an improved accuracy and up to Z=118. Thus, the domain of the work is extended to neutron-deficient and neutron-excess nuclides where B_{expt} are not available, but theoretical binding energies B_{theo} are available [4]. These re-fitted constants have been successfully used in the number of recent calculations [5]-[24] for studying the decay of hot and rotating compound nucleus (CN) formed in heavy ion reactions over a wide range of incident centre-of-mass (c.m.) energies.

A brief outline of the Seeger's mass formula, and the methodology used to workout the temperature-dependent binding energies, are presented in section II. Possible applications of the liquid drop energy in heavy ion reaction studies are also included in this section. The calculations and results are given in section III, together with the table of fitted constants, which could be of huge importance for people working in the relevant area of nuclear physics. Finally, the results are summarized in section IV.

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II. TEMPERATURE-DEPENDENT SEEGER'S MASS FORMULA AND APPLICATIONS

According to the Strutinsky renormalization procedure, the binding energy B of a nucleus at temperature T is the sum of liquid drop energy $V_{LDM}(T)$ and shell corrections $\delta U(T)$

$$B(T) = V_{LDM}(T) + \delta U(T), \tag{1}$$

where V_{LDM} is the semi-empirical mass formula of Seeger [1], with T-dependence introduced by Davidson *et al.* [2], and δU taken as the "empirical" formula of Myers and Swiatecki [25], also made T-dependent to vanish exponentially,

$$\delta U(T) = \delta U \exp(-T^2/T_0^2), \tag{2}$$

with T_0=1.5 MeV [26]. Seeger's liquid drop energy V_{LDM}, with its T-dependence due to Davidson *et al.*, is

$$\begin{aligned} V_{LDM}(A,Z,T) \; &= \; \alpha(T)A + \beta(T)A^{\frac{2}{3}} + \Big(\gamma(T) - \frac{\eta(T)}{A^{\frac{1}{3}}}\Big)\Big[\frac{I^2 + 2|I|}{A}\Big] \\ &+\Big(\frac{Z^2}{r_0(T)A^{\frac{1}{3}}}\Big)\Big[1 - \frac{0.7636}{Z^{\frac{2}{3}}} - \frac{2.29}{[r_0(T)A^{\frac{1}{3}}]^2}\Big] + \delta(T)\frac{f(Z,A)}{A^{\frac{3}{4}}}, \end{aligned} \tag{3}$$

with

$$I = a_a(Z-N), \qquad a_a = 1$$

and, respectively, for even-even, even-odd and odd-odd nuclei,

$$f(Z,A) = (-1,0,1).$$

Seeger's constants of 1961 are [1]:

$$\alpha(0) = -16.11, \quad \beta(0) = 20.21, \quad \gamma(0) = 20.65, \quad \eta(0) = 48.00 \quad \text{(all in MeV)},$$

and the pairing energy $\delta(0)$=33.0 MeV from [27]. In the following, the bulk constant $\alpha(0)$, and the neutron-proton asymmetry constant a_a, are found enough to be readjusted/ refitted to obtain the B_{expt}.

The T-dependence of the constants in Eq. (3) were obtained numerically by Davidson *et al.* [2] from the available experimental information on excited states of 313 nuclei in the mass region 22$\leq A \leq$250 by determining the partition function $\mathcal{Z}(A,Z,T)$ of each nucleus in the canonical ensemble and making a least squares fit of the excitation energy

$$E_{ex}(A,Z,T) = V_{LDM}(A,Z,T) - V_{LDM}(A,Z,0) \tag{4}$$

to the ensemble average

$$E_{ex}(A,Z,T) = T^2\frac{\partial}{\partial T}ln\mathcal{Z}(A,Z,T). \tag{5}$$

The constants $\alpha(T)$, $\beta(T)$, $\gamma(T)$, $\eta(T)$ and $\delta(T)$ are given in Fig. 1 of Ref. [2] for T$\leq$4 MeV, extrapolated linearly for higher temperatures. However, $\delta(T)$ is constrained to be positive definite at all temperatures, and with $\delta(T)$=0 for T>2 MeV. Also, for the bulk constant $\alpha(T)$, instead, an empirically fitted expression using Fermi gas model is obtained, as

$$\alpha(T) = \alpha(0) + \frac{T^2}{15}. \tag{6}$$

For shell effects δU, the empirical formula of Myers and Swiatecki [25] is

$$\delta U = C\left[\frac{F(N)+F(Z)}{(\frac{A}{2})^{\frac{2}{3}}} - cA^{\frac{1}{3}}\right] \tag{7}$$

where

$$F(X) = \frac{3}{5}\left(\frac{M_i^{\frac{5}{3}} - M_{i-1}^{\frac{5}{3}}}{M_i - M_{i-1}}\right)(X - M_{i-1}) - \frac{3}{5}\left(X^{\frac{5}{3}} - M_{i-1}^{\frac{5}{3}}\right)$$

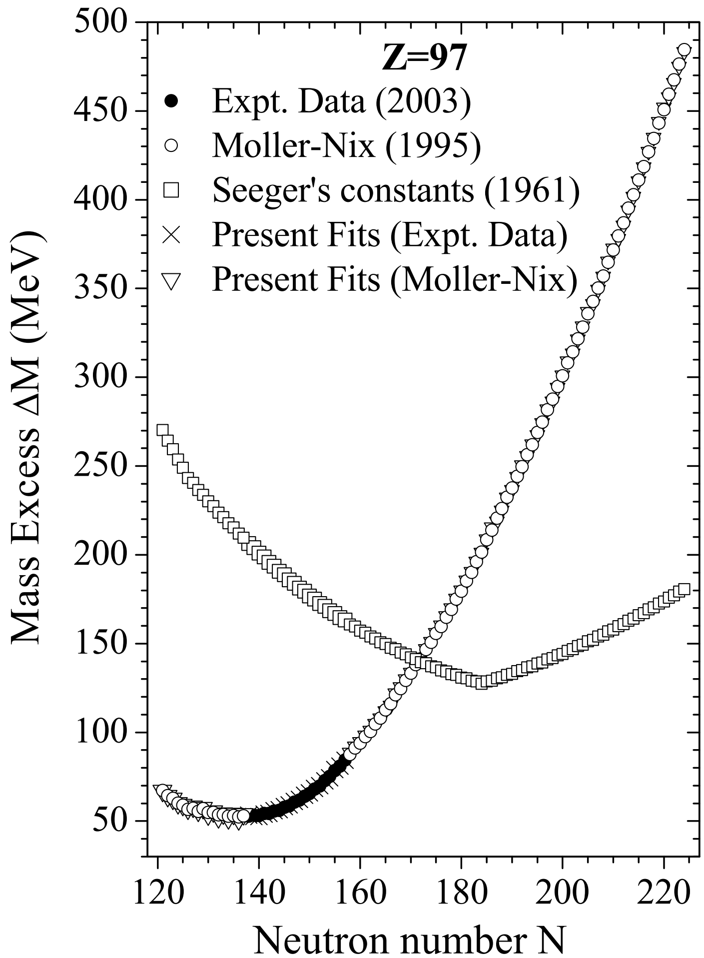

FIG. 1: Mass excess ΔM [$=M_A - A = NM_n + ZM_p + B(Z,N) - A$] in MeV as a function of neutron number N for Z=97, calculated by using the experimental data (solid circles) [3], theoretical data (open circles) [4], with newly fitted constants (crosses and down open triangles) and with the 1961 Seeger's constants [1] (hollow squares).

with $X = N$ or Z, and $M_{i-1} < X < M_i$. M_i are the magic numbers 2, 8, 14 (or 20), 28, 50, 82, 126 and 184 for both neutrons and protons. The constants C=5.8 MeV and c=0.26 MeV. Note that the above formula is for spherical shapes, but the missing deformation effects in δU are included here to some extent via the readjusted constants of V_{LDM} since we essentially use the experimental binding energies split in to two contributions, V_{LDM} and δU, for reasons of adding the T-dependence on it.

Finally, as an application of the two components [$V_{LDM}(T)$ and $\delta U(T)$] of the (T-dependent) experimental binding energy in the field of heavy-ion reactons, we define the collective fragmentation potential

$$\begin{aligned} V(\eta,R,T) &= \sum_{i=1}^{2}[V_{LDM}(A_i,Z_i,T)] + \sum_{i=1}^{2}[\delta U_i]\exp(-T^2/T_0^2) + V_C(R,Z_i,\beta_{\lambda i},\theta_i,T) \\ &+ V_P(R,A_i,\beta_{\lambda i},\theta_i,T) + V_\ell(R,A_i,\beta_{\lambda i},\theta_i,T), \end{aligned} \quad (8)$$

where the nuclear proximity V_P, Coulomb V_C and the angular-momentum ℓ-dependent V_ℓ potentials are for deformed and oriented nuclei and are also T-dependent. For details, see, e.g., Ref. [5].

Based on $V_{R,T}(\eta)$ at fixed R and T, and the scattering potential $V_{\eta,T}(R)$ at fixed η and T, we calculate the CN decay cross-section by using the dynamical cluster-decay model (DCM) of Gupta and collaborators [5]-[24], worked out in terms of the decoupled collective coordinates of mass (and charge) asymmetry $\eta = \frac{A_1-A_2}{A_1+A_2}$ [$\eta_Z = \frac{Z_1-Z_2}{Z_1+Z_2}$] and

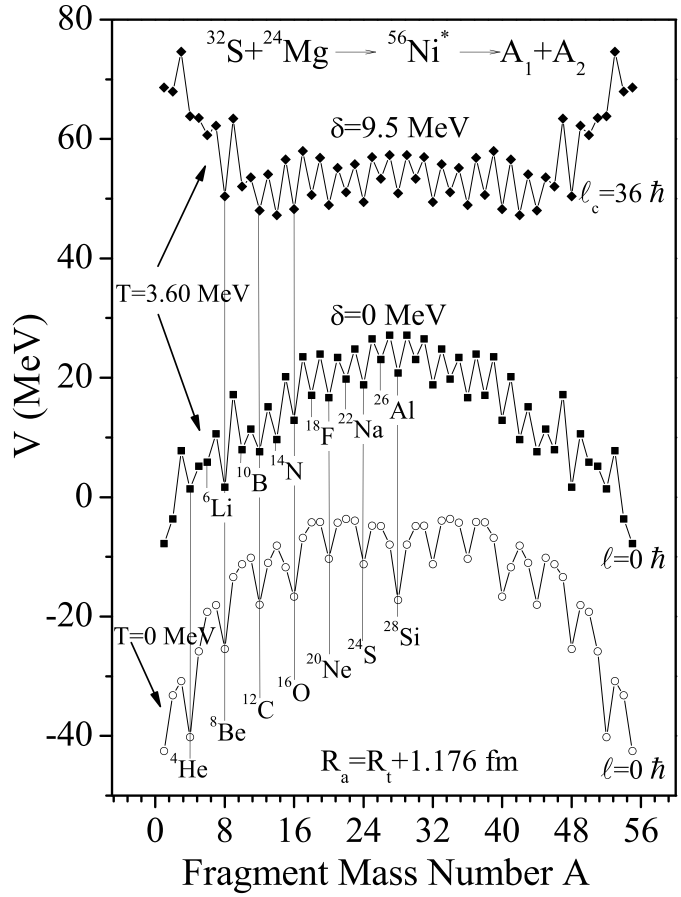

FIG. 2: Fragmentation potential [Eq. (8)] calculated for the decay of ^{56}Ni* formed in ^{32}S+^{24}Mg reaction at T=3.60 MeV for ℓ=0 and 36 $\hbar$, and also at T=0 for ℓ=0 $\hbar$.

relative separation R. In terms of these coordinates, using ℓ partial waves, the CN decay cross section is defined as

$$\sigma = \frac{\pi}{k^2}\sum_{l=0}^{l_{max}}(2l+1)P_0P; \qquad k=\sqrt{\frac{2\mu E_{c.m.}}{\hbar^2}} \tag{9}$$

where the preformation probability P_0, refering to η motion, is the solution of stationary Schrödinger equation in η at a fixed R, and P, the WKB penetrability refers to R motion, both quantities carrying the effects of angular momentum ℓ, temperature T, deformations $\beta_{\lambda i}$ and orientations θ_i degrees of freedom of colliding nuclei with c.m. energy $E_{c.m.}$. $\mu=[A_1A_2/(A_1+A_2)]m$, is the reduced mass, with m as the nucleon mass.

Eq. (9) is applicable to the decay of CN to light particles (LPs, A≤4, Z≤2), intermediate mass fragments (IMFs, 2≤Z≤10), the fusion-fission fragments and the quasi-fission (q.f.) process where the incoming channel does not loose its identity, i.e., P_0=1 for qf. The ℓ_{max} could be fixed for the vanishing of the fusion barrier of the incoming channel, or the light particle cross-section $\sigma_{LPs}\rightarrow 0$, or else defined as the critical $\ell_c = R_a\sqrt{2\mu[E_{c.m.}-V(R_a,\eta_{in},\ell=0)]}/\hbar$.

III. CALCULATIONS AND RESULTS

Table 1 gives the newly fitted constants of Seeger's V_{LDM} for the experimental binding energy B_{expt} [3], and the theoretical B_{theo} values [4] where the experimental data were not available. Interestingly, only the bulk constant $\alpha(0)$, working as an overall scaling factor, and the asymmetry constant a_a, controlling the curvature of the experimental parabola, are required to be re-adjusted. The role of these re-fitted constants is illustrated in Fig. 1 for Z=97 nuclides. We notice in Fig. 1 an excellent agreement between the present fits (crosses and down open triangles) corresponding to experimental (solid circles) [3] and theoretical data (open circles) [4], respectively. The fits are with in 0-1.5 MeV

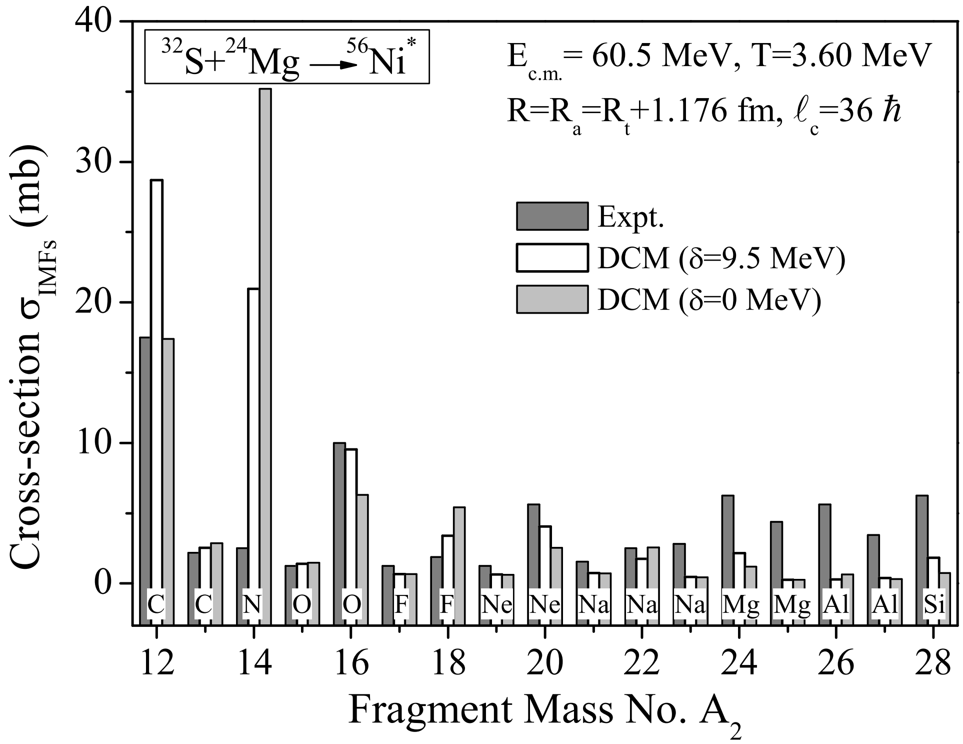

FIG. 3: The calculated IMFs cross-section σ_{IMFs}, using Eq. (9), for the decay of compound system $^{56}Ni^*$ formed in $^{32}S+^{24}Mg$ reaction at T=3.60 MeV, taking pairing constant δ=0 and 9.5 MeV, compared with experimental data [28].

of the available B_{expt} or B_{theo} data. Also plotted in Fig. 1 are the results of calculations using the old 1961 Seeger's constants (hollow squares), showing the requirement and extent to which the fitting can clearly improve upon the older results.

Next, we consider an application of the re-adjusted V_{LDM} with an idea to impress upon the need and to propose here atleast a partially modified variation of the pairing constant δ with temperature T, as compared to that of Davidson *et al.* [2]. Fig. 2 shows the fragmentation potential V(A) for the decay of $^{56}Ni^*$ (a complete mass spectrum) into light particles (LPs) and intermediate mass fragments (IMFs) at T=3.60 MeV for two different ℓ values (ℓ=0 and 36 $\hbar$), compared with one at T =0 for ℓ=0 $\hbar$. We notice that at T =0 for ℓ=0 $\hbar$, the pairing effects are very strong since all the even-even fragments lie at potential energy minima. On the other hand, if we include temperature effects as per prescription of Davidson *et al.* (dashed line in Fig. 4), we find that δ=0 MeV in V_{LDM} for T>2 MeV, and hence in Fig. 2 for T=3.60 MeV, δ=0 MeV, the odd-odd fragments like ^{10}B, ^{14}N, ^{18}F, etc., become equally probable as the even-even fragments, since minima are now equally stronger. The same result was obtained earlier in [12] for the decay of $^{56}Ni^*$ at T=3.39 MeV, since there too δ=0 MeV was used from Davidson *et al.*. However, if we empirically choose δ=9.5 MeV for T=3.60 MeV (for the best fit to IMFs data in Fig. 3), the situation becomes again favourable. In other words, Fig. 2 for T=3.60 MeV, δ=9.5 MeV shows once again that the even-even fragments, like ^{12}C, ^{16}O, etc., are equally favoured as odd-odd ^{14}N, ^{18}F, etc. It is important to note that in this experiment [28] on $^{32}S+^{24}Mg\rightarrow^{56}Ni^*$, only the IMFs are measured, and theoretically LPs are more prominent at lower ℓ-values whereas IMFs seem to supersede them at higher ℓ-values, as is also evident from Fig. 2. The calculated decay cross-sections σ_{IMFs} for IMFs at T=3.60 MeV, for both δ=0 and 9.5 MeV cases are shown in Fig. 3, compared with experimental data [28]. We notice in this figure that better comparisons are obtained for the case of $\delta \neq 0$ calculations, contrary to earlier results in Fig. 13 of [12] for δ=0 MeV, but supporting the one in Fig. 7 of [5] for δ=9.5 MeV. Similar calulations, supporting non-zero δ values at T>2 MeV, are also reported for $^{56}Ni^*$ at T=3.39 MeV in Fig. 7 of [5], and for fusion-fission cross-section in ^{118}Ba (Fig. 2(b) in [6]), and the possible ^{14}C clustering in $^{18,20}O$ and ^{22}Ne nuclei [7]. These calculations lead us to modify the variation of δ as function of T, as shown in Fig. 4 (solid line throgh solid dots). Apparently, many more calculations are needed for Fig. 4 to represent a true $\delta(T)$.

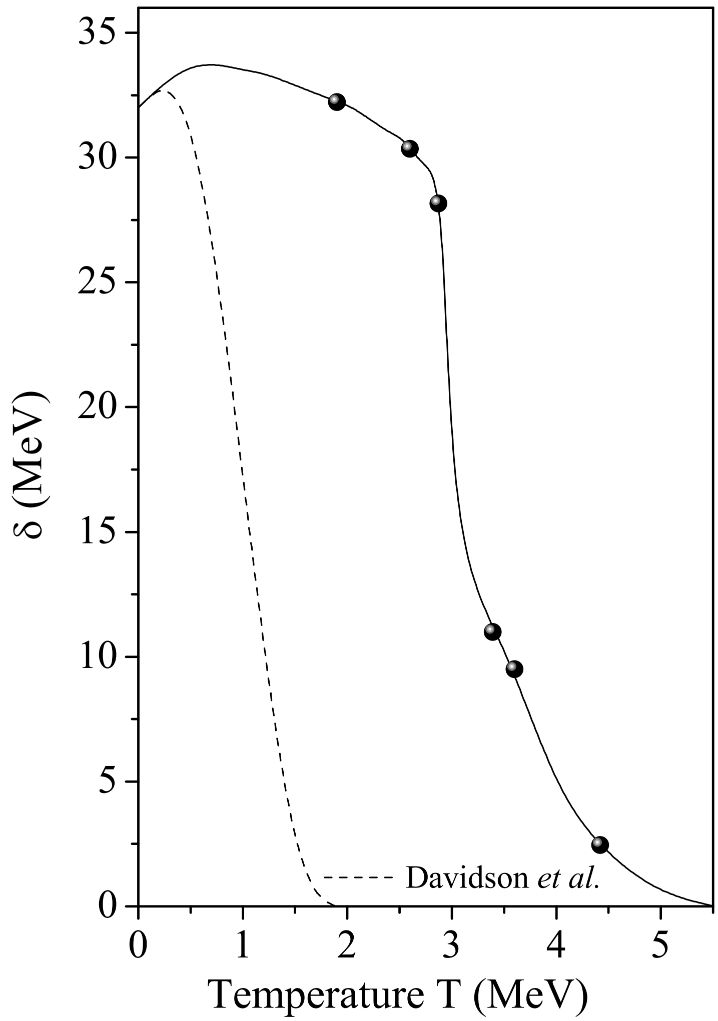

FIG. 4: The pairing energy δ (MeV) as function of temperature T (MeV), readjusted empirically for temperatures T>1.5 MeV (solid line and solid dots), compared with the original curve (dashed line) due to Davidson *et al.* [2].

IV. SUMMARY

In view of the large data for ground state (g.s.) binding energies having become available and to be able to include the T-dependence on binding energies, we have re-fitted two of the constants, the bulk $\alpha(0)$ and neutron-proton asymmetry a_a, of Seeger's mass formula. The experimental g.s. binding energies or theoretical binding energies for neutron- and proton-rich nuclei, where data are not yet available, are fitted within <1.5 MeV, and up to Z=118 nuclei. The method used is the Strutinsky renormalization procedure to define the g.s. binding energy as a sum of the liquid drop energy and the shell correction. Taking shell correction from the empirical formula of Myers and Swiatecki, the two constants of Seeger's liquid drop energy are fitted to obtain the experimental or theoretical binding energy. The fitted constants of liquid drop energy have been used for understanding the dynamics of excited compound nuclear systems, which point out to the inadequacy of the variation of pairing energy constant δ with temperature T. As per the given $\delta(T)$ variation of Davidson *et al.*, δ=0 MeV for T>2 MeV. However, the recent compound nucleus decay calculations suggest that $\delta \neq 0$ for T> 2 MeV and hence clearly indicate the need for re-evaluation of the T-dependence of Seeger's constants. A new dependence of $\delta(T)$ is suggested on the basis of already published calculations for compound nucleus decay studies. Need for further studies are clealy indicated.

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TABLE I: Re-fitted bulk $\alpha(0)$ and asymmetry a_a constants for Seeger's liquid drop energy in 1≤Z ≤118 nuclei, *w.r.t.* B_{expt} (for nuclei upto Z=7, and Z≥8 marked with star) and B_{theo} (only for Z≥8 and where experimental data were not available).

Z	N	$\alpha(0)$	a_a	Z	N	$\alpha(0)$	a_a	Z	N	$\alpha(0)$	a_a
1	2	-15.85	0.100	6	3,11	-14.81	0.100	10	25,26	-16.25	0.856
	3	-16.93	0.120		4,9	-15.65	0.100		27	-16.25	0.848
	4	-13.37	0.100		5,6†,7	-16.53	0.100		28	-16.25	0.839
	5	-13.57	0.120		8	-15.92	0.100		29	-16.25	0.833
	6	-11.49	0.100		10	-15.09	0.100		30	-16.25	0.826
2	1	-15.18	0.100		12,13	-15.04	0.800		31	-16.25	0.815
	2	-16.11	0.100		14	-14.83	0.800	11	(7,8)*	-15.91	0.920
	3	-16.90	0.300		15,16	-14.99	0.800		(9,21,23)*	-16.21	0.861
	4,5	-14.23	0.300	7	3	-14.27	0.200		(10-13)*	-16.27	0.865
	6	-13.12	0.100		4	-15.12	0.530		14*	-16.06	0.800
	7	-12.87	0.100		5,9	-16.20	0.800		(15-20,22,24)*	-16.18	0.865
	8	-11.37	0.200		6	-16.53	0.800		(25,26)*	-16.21	0.852
3	0	-09.73	0.100		7	-16.75	0.800		27,28	-16.21	0.833
	1,4,5	-16.67	0.100		8	-16.35	0.800		29	-16.27	0.832
	2	-17.00	0.100		10,11,15	-15.90	0.940		30	-16.27	0.825
	3	-18.43	0.990		12,13	-15.70	0.890		31	-16.27	0.815
	6	-13.70	0.980		14	-15.68	0.940		32	-16.27	0.809
	7	-14.37	0.400		16	-15.97	0.940		33	-16.27	0.801
	8	-13.16	0.100		17,18	-16.10	0.930	12	7*	-15.70	0.967
	9	-12.99	0.100	8	4*	-14.00	0.940		8*	-15.86	0.958
4	1	-12.37	0.010		5*	-15.30	0.940		(9,10)*	-16.07	0.920
	2	-14.45	0.100		(6,10,11,13)*	-15.93	0.940		(11-13)*	-16.23	0.842
	3	-16.12	0.800		(7,8)*	-16.24	0.500		(14-26)*	-16.18	0.842
	4	-17.05	0.980		(9,15,16)*	-16.17	0.950		(27,28)*	-16.18	0.835
	5	-16.70	0.600		(12,14)*	-15.85	0.940		29	-16.33	0.837
	6	-15.50	0.800		(17,19,20)*	-16.09	0.895		30	-16.03	0.792
	7	-15.23	0.500		18*	-16.01	0.895		31	-16.03	0.785
	8	-14.24	0.100		21,22	-16.19	0.898		32,34,35	-16.09	0.773
	9	-14.04	0.100		23,24	-16.38	0.895		33	-16.03	0.776
	10	-13.28	0.010		25,26	-16.19	0.867	13	8*	-15.95	0.950
	11	-12.96	0.100	9	5*	-15.19	0.800		(9,10)*	-16.10	0.930
	12	-12.23	0.100		(6,12,13)*	-15.78	0.500		(11-19)*,(25-28)*	-16.26	0.842
5	1	-13.10	0.100		(7,8,10,11,15,16,18)*	-16.17	0.910		(20-24)*	-16.22	0.845
	2	-14.53	0.100		9*	-16.30	0.900		29*	-16.41	0.850
	3	-16.43	0.100		14*	-15.95	0.900		30	-16.11	0.799
	4	-16.65	0.600		(17,19,20)*	-16.17	0.895		31	-16.11	0.787
	5	-17.16	0.100		(21,22)*	-16.17	0.880		32	-16.11	0.771
	6	-16.57	0.600		23-26	-16.25	0.866		33-36	-16.00	0.763
	7	-16.30	0.100		27	-16.25	0.855		37,38	-16.08	0.764
	8	-15.33	0.100		28	-16.25	0.846	14	8*	-15.95	0.965
	9	-15.12	0.100		29	-16.25	0.839		(9,10)*	-16.04	0.932
	10	-14.40	0.100	10	6*	-15.22	0.500		(11,12)*	-16.17	0.965
	11	-14.10	0.100		(7,14)*	-15.70	0.500		(13-20,27,28)*	-16.27	0.839
	12	-13.41	0.100		(8,13)*	-15.89	0.500		(21-26)*	-16.23	0.841
	13	-13.10	0.100		(9-12)*,(15-18)*	-16.16	0.910		(29,30)*	-16.31	0.836
	14	-12.92	0.400		(19-22)*	-16.22	0.882		31	-16.09	0.776
6	2	-12.95	0.010		(23,24)*	-16.29	0.876		32-35	-16.05	0.762

† For Z=6, N=6, $\alpha(0)$=-16.72 instead of -16.53.

Continued 1 .... Table 1

Z	N	$\alpha(0)$	a_a	Z	N	$\alpha(0)$	a_a	Z	N	$\alpha(0)$	a_a
14	36,37	-16.09	0.762	19	51	-16.21	0.734	25	15,16	-16.38	0.758
	38	-16.09	0.758	20	10	-16.17	0.834		17,18	-16.48	0.780
	39,40	-16.09	0.754		11	-16.17	0.806		(19-26)*	-16.46	0.760
15	8	-16.10	0.970		12	-16.17	0.771		(27-44)*	-16.42	0.768
	(9-14)*	-16.31	0.939		13	-16.17	0.718		45,46	-16.43	0.761
	(15-24)*	-16.40	0.893		(14-21)*	-16.49	0.899		47-52	-16.21	0.715
	(25-28)*	-16.12	0.783		(22-30)*	-16.37	0.789		53-59	-16.17	0.706
	(29-31)*	-16.11	0.762		(31-34)*	-16.43	0.783		60-64	-16.17	0.704
	32-36	-16.11	0.762		(35-37)*	-16.49	0.789	26	16-18	-16.44	0.765
	37,38	-16.09	0.754		38-49	-16.22	0.735		(19-26)*	-16.47	0.770
	39-42	-16.09	0.749		50,51	-16.22	0.732		(27-45)*	-16.43	0.768
16	8	-16.11	0.955		52,53	-16.17	0.723		46*	-16.47	0.770
	9	-16.11	0.907	21	11,12	-16.17	0.770		47	-16.40	0.750
	(10-14)*	-16.31	0.925		13,14	-16.29	0.770		48-62	-16.17	0.702
	(15-24)*	-16.40	0.893		(15-21)*	-16.47	0.795		63-66	-16.17	0.700
	(25-28)*	-16.31	0.828		(22,23,31,33,35-39)*	-16.43	0.779	27	17	-16.50	0.782
	(29-30)*	-16.22	0.775		(24-30,32,34)*	-16.36	0.774		18,19	-16.50	0.761
	(31-33)*	-16.25	0.773		40-50	-16.23	0.733		(20-27)*	-16.48	0.755
	34-38	-16.11	0.751		51,52	-16.23	0.729		(28-46)*	-16.44	0.767
	39	-16.20	0.758		53-55	-16.17	0.718		(47,48)*	-16.47	0.767
	40-44	-16.20	0.755	22	12	-16.25	0.790		49,50	-16.42	0.750
17	8	-16.11	0.914		13,14	-16.25	0.765		51-62	-16.18	0.701
	9,10	-16.17	0.864		15	-16.25	0.700		63-69	-16.18	0.700
	(11-14,22-28)*	-16.32	0.822		(16-23)*	-16.44	0.775	28	18	-16.50	0.774
	(15-21)*	-16.46	0.893		(24-30)*	-16.39	0.803		19	-16.50	0.760
	(29-30)*	-16.27	0.775		(31-41)*	-16.39	0.768		(20-29,46-48)*	-16.48	0.769
	(31-34)*	-16.35	0.778		42-46,49-51	-16.24	0.729		30-45)*	-16.45	0.770
	35-40	-16.20	0.755		47,48	-16.24	0.731		(49,50)*	-16.22	0.702
	41,42	-16.20	0.747		52,53	-16.17	0.717		51-55	-16.22	0.702
	43,44	-16.20	0.745		54-56	-16.17	0.715		56-60	-16.21	0.702
	45,46	-16.20	0.743		57,58	-16.17	0.712		61-71	-16.21	0.700
18	9	-16.17	0.864	23	13,14	-16.17	0.721	29	19-22	-16.54	0.750
	10,11	-16-17	0.811		15,16	-16.44	0.790		(23-30)*	-16.51	0.720
	(12-14)*	-16.40	0.893		(17-25)*	-16.45	0.768		(31-44)*	-16.51	0.790
	(15-19)*	-16.46	0.893		(26-30)*	-16.39	0.792		(45-51)*	-16.44	0.751
	(20-25)*	-16.43	0.899		(31-42)*	-16.40	0.768		52-55	-16.24	0.700
	(26-28)*	-16.25	0.775		43-50	-16.25	0.729		56-73	-16.23	0.700
	(29-31)*	-16.35	0.785		51-53	-16.19	0.718	30	21-23	-16.55	0.740
	(32-35)*	-16.35	0.772		54-56	-16.21	0.717		(24-33)*	-16.52	0.700
	36-41	-16.21	0.745		57-60	-16.19	0.712		(34-40)*	-16.52	0.794
	42,43,47-49	-16.21	0.741	24	14	-16.30	0.765		(41-53)*	-16.40	0.730
	44-46	-16.21	0.739		15,16	-16.38	0.765		54-57	-16.28	0.700
19	10	-16.17	0.830		17	-16.44	0.765		58-75	-16.26	0.700
	11,12	-16.20	0.787		(18-25,42,43)*	-16.45	0.770	31	22-24	-16.56	0.720
	(13-21)*	-16.49	0.899		(26-29)*	-16.40	0.795		(25-33)*	-16.57	0.749
	(22-28)*	-16.36	0.813		(30-41)*	-16.42	0.774		(34-45)*	-16.53	0.789
	(29-32)*	-16.37	0.779		44-46,59-62	-16.17	0.706		(46-53)*	-16.41	0.727
	(33-36)*	-16.44	0.783		47-51	-16.21	0.720		(54,55)*	-16.44	0.727
	37-42,45-48	-16.21	0.740		52,53	-16.17	0.710		56-63	-16.30	0.700
	43,44,49,50	-16.21	0.738		54-58	-16.17	0.708		64-77	-16.28	0.700

Continued 2 .... Table 1

Z	N	$\alpha(0)$	a_a	Z	N	$\alpha(0)$	a_a	Z	N	$\alpha(0)$	a_a
32	23-25	-16.58	0.720	38	$(35\text{-}39)^*$	-16.67	0.735	43	$(42,43,70\text{-}72)^*$	-16.73	0.755
	$(26\text{-}33)^*$	-16.58	0.749		$(40\text{-}42,64\text{-}67)^*$	-16.63	0.742		$(44,45)^*$	-16.70	0.748
	$(34\text{-}45)^*$	-16.55	0.795		$(43\text{-}54)^*$	-16.58	0.748		$(46\text{-}54)^*$	-16.66	0.787
	$(46\text{-}57)^*$	-16.41	0.719		$(55\text{-}63)^*$	-16.57	0.734		$(55\text{-}69)^*$	-16.61	0.728
	58	-16.34	0.701		68-71	-16.47	0.705		$(73\text{-}75)^*$	-16.72	0.748
	59-80	-16.32	0.701		72-79	-16.47	0.708		76-80	-16.55	0.711
33	24-26	-16.60	0.720		80-85	-16.21	0.673		81-88	-16.55	0.707
	$(27\text{-}34)^*$	-16.60	0.750		86-87	-16.21	0.674		89-103	-16.30	0.674
	$(35\text{-}46)^*$	-16.56	0.798		88-93	-16.19	0.674		104	-16.30	0.675
	$(47\text{-}59)^*$	-16.44	0.721	39	31-36	-16.70	0.702	44	37,38	-16.77	0.704
	60-76	-16.38	0.707		$(37\text{-}40)^*$	-16.68	0.747		39-42	-16.73	0.709
	77-80	-16.34	0.702		$(41\text{-}43)^*$	-16.64	0.805		$(43,44,75,76)^*$	-16.73	0.748
	81,82	-16.34	0.700		$(44,45,63\text{-}69)^*$	-16.59	0.730		$(45,46,72\text{-}74)^*$	-16.71	0.747
34	25-30	-16.60	0.701		$(46\text{-}62)^*$	-16.57	0.730		$(47\text{-}56)^*$	-16.68	0.788
	$(31\text{-}36)^*$	-16.60	0.700		70,71,81	-16.50	0.708		$(57\text{-}71)^*$	-16.62	0.728
	$(37\text{-}46)^*$	-16.57	0.797		72-80	-16.51	0.712		77-79	-16.57	0.712
	$(47\text{-}60)^*$	-16.46	0.721		82-86	-16.22	0.672		80,81	-16.57	0.710
	61-73	-16.37	0.701		87-95	-16.22	0.674		82-90	-16.57	0.707
	74-77	-16.37	0.703	40	32-37	-16.72	0.702		91-103	-16.32	0.674
	78-84	-16.11	0.675		$(38\text{-}40)^*$	-16.70	0.760		104-106	-16.33	0.676
35	26-31	-16.62	0.700		$(41,42,67\text{-}70)^*$	-16.68	0.747	45	38-40	-16.76	0.674
	$(32\text{-}37)^*$	-16.62	0.760		$(43\text{-}46)^*$	-16.64	0.805		41-43	-16.74	0.674
	$(38\text{-}46)^*$	-16.58	0.799		$(47\text{-}66)^*$	-16.59	0.730		$(44,45)^*$	-16.74	0.700
	$(47\text{-}62)^*$	-16.48	0.722		71,72,78-81	-16.51	0.708		$(46,47,75\text{-}77)^*$	-16.72	0.746
	63-74	-16.42	0.707		73-77	-16.53	0.714		$(48\text{-}57)^*$	-16.69	0.787
	75,76	-16.37	0.703		82,83	-16.53	0.709		$(58\text{-}74)^*$	-16.63	0.727
	77-80	-16.40	0.704		84-87	-16.53	0.707		78-80	-16.57	0.710
	81,82	-16.40	0.702		88-97	-16.24	0.674		81-91	-16.57	0.706
	83-86	-16.40	0.700	41	33-39	-16.73	0.708		92-93	-16.59	0.707
36	27-32	-16.64	0.702		$(40\text{-}42,70\text{-}72)^*$	-16.70	0.747		94-103	-16.35	0.676
	$(33\text{-}38)^*$	-16.63	0.652		$(43,44,66\text{-}69)^*$	-16.67	0.746		104-108	-16.35	0.677
	$(39\text{-}48)^*$	-16.59	0.799		$(45\text{-}51)^*$	-16.64	0.794	46	40-42	-16.77	0.684
	$(49\text{-}64)^*$	-16.49	0.719		$(52\text{-}65)^*$	-16.59	0.728		43-44	-16.76	0.689
	65-73	-16.44	0.706		73-80	-16.51	0.708		$(45,46)^*$	-16.76	0.710
	74-76	-16.44	0.709		81-84	-16.51	0.705		$(47\text{-}48,76\text{-}78)^*$	-16.73	0.746
	77-79	-16.49	0.713		85-87	-16.51	0.704		$(49\text{-}61)^*$	-16.71	0.780
	80-84	-16.15	0.672		88-99	-16.26	0.674		$(62\text{-}75)^*$	-16.64	0.727
	85-88	-16.15	0.674	42	35-39	-16.74	0.711		79	-16.59	0.711
37	29-33	-16.66	0.702		40	-16.71	0.711		80-91	-16.59	0.707
	$(34\text{-}39)^*$	-16.65	0.740		$(41,42,72,73)^*$	-16.72	0.748		92-94	-16.59	0.705
	$(40\text{-}48)^*$	-16.60	0.799		$(43,44,68\text{-}71)^*$	-16.69	0.748		95-105	-16.40	0.680
	$(49\text{-}65)^*$	-16.51	0.720		$(45\text{-}54)^*$	-16.66	0.788		106-110	-16.35	0.676
	66-72	-16.45	0.705		$(55\text{-}67)^*$	-16.60	0.728	47	41,42	-16.79	0.684
	73-78	-16.45	0.708		74-80	-16.53	0.709		43-45	-16.77	0.690
	79-84	-16.17	0.672		81-89	-16.53	0.705		$(46,81\text{-}83)^*$	-16.78	0.746
	85,86	-16.16	0.672		90-102	-16.28	0.674		$(47\text{-}49,78\text{-}80)^*$	-16.75	0.745
	87-91	-16.17	0.674	43	36-38	-16.75	0.704		$(50\text{-}62)^*$	-16.72	0.780
38	30-34	-16.68	0.702		39-41	-16.73	0.709		$(63\text{-}77)^*$	-16.65	0.726

Continued 3 .... Table 1

Z	N	$\alpha(0)$	a_a	Z	N	$\alpha(0)$	a_a	Z	N	$\alpha(0)$	a_a
47	84-93	-16.59	0.705	52	47-50	-16.86	0.680	56	(77-92)*	-16.73	0.712
	94-95	-16.57	0.701		51,52	-16.84	0.630		98-120	-16.70	0.700
	96-101	-16.39	0.677		(53-59)*	-16.81	0.885		121-131	-16.54	0.681
	102-105	-16.34	0.672		(60-66)*	-16.78	0.796		132,133	-16.54	0.680
	106-113	-16.39	0.679		(67-79)*	-16.70	0.723	57	53-56	-16.91	0.600
48	42-44	-16.80	0.678		(80-90)*	-16.69	0.713		57,58	-16.89	0.600
	45,46	-16.78	0.695		91-98	-16.64	0.702		59	-16.88	0.600
	(47-49,80-82)*	-16.77	0.745		99-109	-16.64	0.700		(60-62)*	-16.87	0.735
	(50-63)*	-16.74	0.786		110,111,123,124	-16.48	0.680		(63-74)*	-16.85	0.789
	(64-79)*	-16.66	0.725		112-122	-16.47	0.680		(75-81)*	-16.77	0.727
	(83,84)*	-16.67	0.720	53	48-50	-16.86	0.600		(82-98)*	-16.70	0.698
	85-88,93-96	-16.61	0.705		51,52	-16.85	0.685		99-117	-16.71	0.701
	89-92	-16.58	0.702		53,54	-16.83	0.685		118-132	-16.54	0.680
	97-100	-16.39	0.674		(55-60)*	-16.82	0.885		133-135	-16.55	0.680
	101-105	-16.41	0.678		(61-68)*	-16.80	0.798	58	55,56	-16.93	0.600
	106-115	-16.39	0.677		(69-81)*	-16.72	0.725		57	-16.92	0.600
49	43-46	-16.82	0.678		(82-91)*	-16.70	0.713		58-60	-16.91	0.600
	47	-16.80	0.695		92-98	-16.64	0.700		(61,62,97-99)*	-16.89	0.736
	(48-51,78)*	-16.78	0.752		99-109	-16.66	0.701		(63-66,90-92)*	-16.87	0.746
	(52-64)*	-16.75	0.789		110-118,123-126	-16.49	0.680		(67-76)*	-16.86	0.788
	(65-77)*	-16.67	0.727		119-122	-16.48	0.680		(77-89)*	-16.77	0.720
	(79-86)*	-16.67	0.718	54	49-52	-16.87	0.600		(93-96)*	-16.80	0.720
	87-97	-16.61	0.704		53,54	-16.85	0.600		100-119	-16.74	0.703
	98-102	-16.39	0.673		55	-16.84	0.600		120-128	-16.57	0.682
	103-105	-16.41	0.677		(56-60)*	-16.84	0.889		129-137	-16.37	0.661
	106-117	-16.42	0.679		(61-68)*	-16.81	0.799	59	56-58	-16.95	0.600
50	44-46	-16.84	0.639		(69-83)*	-16.74	0.726		59-61	-16.93	0.600
	47,48	-16.82	0.600		(84-93)*	-16.71	0.712		(62-69)*	-16.91	0.850
	(49-52)*	-16.80	0.990		94-97	-16.66	0.700		(70-80)*	-16.86	0.772
	(53-64)*	-16.76	0.798		98-113	-16.67	0.700		(81-92)*	-16.76	0.710
	(65-77)*	-16.68	0.725		114,125-128	-16.51	0.680		(93-100)*	-16.75	0.702
	(78-81)*	-16.68	0.719		115-124	-16.50	0.680		101-118	-16.78	0.708
	(82-87)*	-16.68	0.715	55	51-53	-16.88	0.600		119-130	-16.59	0.683
	88-97	-16.63	0.706		54,55	-16.87	0.600		131-139	-16.40	0.663
	98-102	-16.43	0.676		56	-16.86	0.600	60	58-60	-16.97	0.600
	103-106	-16.44	0.679		(57-63)*	-16.85	0.889		61,62	-16.95	0.600
	107-119	-16.43	0.679		(64-71)*	-16.83	0.797		63	-16.92	0.600
51	46-49	-16.84	0.639		(72-76,92-96)*	-16.73	0.713		(64-76)*	-16.92	0.834
	50,51	-16.82	0.630		(77-91)*	-16.71	0.712		(77-86)*	-16.82	0.735
	(52-59)*	-16.80	0.885		97-115	-16.68	0.700		(87-91)*	-16.75	0.702
	(60-65)*	-16.77	0.797		116-124	-16.53	0.682		(92-101)*	-16.75	0.699
	(66-78)*	-16.69	0.724		125-130	-16.53	0.681		102-119	-16.79	0.708
	(79-88)*	-16.69	0.717	56	52-54	-16.90	0.600		120-130	-16.61	0.684
	89-95	-16.64	0.706		55,56	-16.88	0.600		131-141	-16.42	0.663
	96-100	-16.64	0.704		57	-16.87	0.600	61	59,60	-16.99	0.600
	101-106	-16.64	0.702		(58-62)*	-16.87	0.890		61,62	-16.97	0.600
	107-111	-16.45	0.679		(63-71)*	-16.84	0.797		63,64	-16.95	0.600
	112-121	-16.43	0.678		(72-76,93-97)*	-16.75	0.713		(65-77)*	-16.93	0.840

Continued 4 .... Table 1

Z	N	$\alpha(0)$	a_a	Z	N	$\alpha(0)$	a_a	Z	N	$\alpha(0)$	a_a
61	$(78\text{-}85)^*$	-16.84	0.745	66	67,68	-17.02	0.826	70	124-131	-16.86	0.705
	$(86\text{-}102)^*$	-16.75	0.695		69,70	-17.01	0.826		132-164	-16.65	0.672
	103-105	-16.79	0.705		71	-16.99	0.826	71	75	-17.03	0.603
	106-118	-16.79	0.707		$(72\text{-}77)^*$	-17.00	0.930		76-78	-17.03	0.910
	119-128	-16.62	0.684		$(78\text{-}85)^*$	-16.92	0.768		$(79\text{-}88)^*$	-17.00	0.797
	129-144	-16.43	0.662		$(86\text{-}91)^*$	-16.84	0.700		$(89\text{-}113)^*$	-16.93	0.717
62	61,62	-17.00	0.600		$(92\text{-}107)^*$	-16.86	0.709		114-124	-16.95	0.723
	63-64	-16.98	0.826		108-124	-16.87	0.713		125-130	-16.87	0.706
	65	-16.96	0.826		125-129	-16.80	0.701		131-163	-16.66	0.672
	$(66\text{-}76)^*$	-16.95	0.859		130-150	-16.53	0.664		164-166	-16.65	0.672
	$(77\text{-}85)^*$	-16.86	0.747		151-155	-16.52	0.664	72	77-80	-17.03	0.845
	$(86\text{-}103)^*$	-16.78	0.700	67	69,70	-17.01	0.826		$(81\text{-}93)^*$	-17.00	0.770
	104-106	-16.80	0.705		71,72	-17.01	0.826		$(94\text{-}116)^*$	-16.94	0.718
	107-122	-16.80	0.707		$(73\text{-}78)^*$	-17.00	0.930		117,118	-16.95	0.721
	123-134	-16.64	0.684		$(79\text{-}87)^*$	-16.93	0.768		119-131	-16.88	0.706
	135-146	-16.44	0.661		$(88\text{-}93)^*$	-16.85	0.700		132-134,148-152	-16.68	0.672
63	62	-17.01	0.826		$(94\text{-}108)^*$	-16.88	0.712		135-147,153-164	-16.67	0.672
	63,64	-17.00	0.826		109-123	-16.90	0.718		165-168	-16.78	0.683
	65,66	-16.98	0.826		124-129	-16.81	0.701	73	78,79	-17.05	0.845
	$(67\text{-}74)^*$	-16.96	0.889		130-135	-16.58	0.669		80,81	-17.04	0.845
	$(75\text{-}84)^*$	-16.90	0.777		136-153	-16.56	0.666		$(82\text{-}93)^*$	-17.01	0.772
	$(85\text{-}104)^*$	-16.79	0.699		154-157	-16.56	0.667		$(94\text{-}117)^*$	-16.95	0.719
	105-109	-16.81	0.706	68	70	-17.05	0.826		118	-16.89	0.704
	110-120	-16.81	0.708		71,72	-17.03	0.826		119-133	-16.89	0.706
	121-131	-16.65	0.685		73,74	-17.01	0.826		134-136	-16.90	0.706
	132-148	-16.45	0.661		$(75\text{-}80)^*$	-17.00	0.870		137-160	-16.68	0.672
64	64	-17.01	0.826		$(81\text{-}84)^*$	-16.91	0.724		161-167	-16.79	0.683
	65,66	-17.00	0.826		$(85\text{-}109)^*$	-16.89	0.712		168-170	-16.79	0.684
	67,68	-16.98	0.826		110-123	-16.91	0.718	74	80-83	-17.06	0.845
	69	-16.97	0.826		124-130	-16.83	0.703		$(84\text{-}96)^*$	-17.02	0.762
	$(70\text{-}75)^*$	-16.97	0.889		131-156	-16.59	0.668		$(97\text{-}118)^*$	-16.97	0.723
	$(76\text{-}85)^*$	-16.91	0.773		157-159	-16.58	0.668		119-134	-16.90	0.706
	$(86\text{-}105)^*$	-16.81	0.701	69	72,73	-17.04	0.881		135-152	-16.70	0.672
	106-112	-16.82	0.706		74,75	-17.00	0.708		153-162	-16.70	0.673
	113-120	-16.82	0.708		$(76\text{-}85)^*$	-16.99	0.820		163-173	-16.90	0.693
	121-134	-16.67	0.685		$(86\text{-}95)^*$	-16.91	0.720	75	81-84	-17.07	0.845
	135-150	-16.48	0.662		$(96\text{-}110)^*$	-16.90	0.712		$(85\text{-}97)^*$	-17.03	0.766
65	65,66	-17.02	0.826		111-124	-16.92	0.719		$(98\text{-}102)^*$	-16.97	0.716
	67,68	-17.00	0.826		125-131	-16.85	0.705		$(103\text{-}119)^*$	-16.97	0.721
	69,70	-16.99	0.826		132-157	-16.60	0.668		120-136	-16.91	0.706
	$(71\text{-}76)^*$	-16.99	0.930		158-161	-16.59	0.668		137-151	-16.71	0.672
	$(77\text{-}85)^*$	-16.91	0.767	70	73,74	-17.04	0.778		152-161	-16.71	0.673
	$(86\text{-}103)^*$	-16.82	0.699		75	-17.01	0.642		162-175	-16.88	0.691
	$(104\text{-}106)^*$	-16.82	0.702		76,77	-17.00	0.786	76	83-85	-17.08	0.845
	107-115	-16.85	0.711		$(78\text{-}87)^*$	-17.00	0.813		$(86\text{-}95)^*$	-17.06	0.795
	116-121	-16.83	0.709		$(88\text{-}108)^*$	-16.91	0.711		$(96\text{-}100)^*$	-17.02	0.743
	122-134	-16.68	0.686		$(109\text{-}111)^*$	-16.90	0.711		$(101\text{-}120)^*$	-16.98	0.720
	135-153	-16.52	0.665		112-123	-16.93	0.720		121-136	-16.92	0.706

Continued 5 .... Table 1

Z	N	$\alpha(0)$	a_a	Z	N	$\alpha(0)$	a_a	Z	N	$\alpha(0)$	a_a
76	137-142	-16.72	0.671	82	134-143	-17.00	0.712	87	111	-17.25	0.845
	143-152	-16.72	0.672		144-159	-16.86	0.685		$(112\text{-}117)^*$	-17.14	0.759
	153-163	-16.73	0.674		160-165	-16.87	0.687		$(118\text{-}129)^*$	-17.09	0.728
	164-166	-17.02	0.705		166-188	-16.86	0.685		$(130\text{-}145)^*$	-17.01	0.700
	167-170	-17.03	0.705		189-191	-16.86	0.684		146-153	-16.95	0.688
	171-177	-16.80	0.683	83	95,96	-17.14	0.845		154-163	-16.95	0.690
77	85,86	-17.09	0.845		97-100	-17.15	0.845		164-189	-16.95	0.691
	$(87\text{-}94)^*$	-17.06	0.780		$(101\text{-}113)^*$	-17.08	0.747		190-192	-16.90	0.685
	$(95\text{-}105)^*$	-17.02	0.740		$(114\text{-}135)^*$	-17.03	0.717		193-195	-16.90	0.684
	$(106\text{-}122)^*$	-16.98	0.718		136-140	-17.01	0.713		196-199,201	-16.90	0.683
	123-138	-16.93	0.706		141-154	-16.88	0.686		200,202	-16.90	0.682
	139-143	-16.73	0.671		155-193	-16.86	0.684	88	104-107	-17.23	0.845
	144-150	-16.73	0.672	84	97-98	-17.16	0.845		108,109	-17.24	0.845
	151-167	-16.81	0.683		99-101	-17.17	0.845		110,111	-17.25	0.845
	168-179	-16.77	0.680		102,103	-17.18	0.845		112,113	-17.26	0.845
78	87	-17.10	0.845		$(104\text{-}115)^*$	-17.10	0.751		$(114\text{-}120)^*$	-17.15	0.755
	$(88\text{-}97)^*$	-17.08	0.798		$(116\text{-}136)^*$	-17.04	0.717		$(121\text{-}130)^*$	-17.10	0.728
	$(98\text{-}105)^*$	-17.05	0.755		137-140	-16.90	0.685		$(131\text{-}146)^*$	-17.02	0.699
	$(106\text{-}124)^*$	-16.99	0.718		141-152	-16.90	0.686		147-153	-16.96	0.687
	125-140	-16.94	0.706		153-156	-16.90	0.687		154-160	-16.96	0.689
	141-150	-16.74	0.671		157-171	-16.90	0.688		161-164	-16.96	0.690
	151-166	-16.82	0.683		172-193	-16.89	0.686		165-189	-16.96	0.691
	167-182	-16.76	0.678		194,195	-16.89	0.685		190,191	-16.92	0.686
79	88,89	-17.11	0.845	85	99,100	-17.18	0.845		192-195	-16.92	0.685
	$(90\text{-}98)^*$	-17.09	0.801		101-103	-17.19	0.845		196-199	-16.92	0.684
	$(99\text{-}106)^*$	-17.06	0.759		104,105	-17.20	0.845		200-202	-16.92	0.683
	$(107\text{-}126)^*$	-16.99	0.715		106,107	-17.21	0.845		203,204	-16.92	0.682
	127-136	-16.97	0.711		$(108\text{-}116)^*$	-17.11	0.751	89	106-111	-17.24	0.834
	137-164,171-184	-16.83	0.684		$(117\text{-}138)^*$	-17.05	0.718		112,113	-17.26	0.845
	165-170	-16.84	0.686		139-149	-16.91	0.685		114	-17.27	0.845
80	90	-17.12	0.845		150-154,194-197	-16.91	0.686		115	-17.28	0.845
	$(91\text{-}103)^*$	-17.09	0.783		155-188	-16.91	0.688		116	-17.29	0.845
	$(104\text{-}111)^*$	-17.05	0.743		189-193	-16.92	0.688		$(117\text{-}127)^*$	-17.15	0.749
	$(112\text{-}130)^*$	-16.99	0.713	86	100-102	-17.20	0.845		$(128\text{-}147)^*$	-17.04	0.701
	131-139	-16.98	0.711		103-105	-17.21	0.845		148-169	-17.05	0.703
	140-163,168-186	-16.84	0.684		106-108	-17.22	0.845		170-181	-16.96	0.690
	164-167	-16.85	0.686		$(109\text{-}120)^*$	-17.13	0.753		182-189	-16.90	0.684
81	92-94	-17.13	0.845		$(121\text{-}125,132)^*$	-17.02	0.700		190-192	-16.90	0.683
	$(95\text{-}106)^*$	-17.08	0.765		$(126\text{-}131,133\text{-}142)^*$	-17.02	0.706		193-197	-16.90	0.682
	$(107\text{-}131)^*$	-17.01	0.716		143-152	-16.92	0.684		198-202	-16.90	0.681
	132-140	-16.99	0.712		153-162	-16.93	0.688		203-206	-16.90	0.680
	141-159,166-175	-16.85	0.685		163-189	-16.92	0.688	90	108-113	-17.25	0.830
	160-165	-16.85	0.686		190-193	-16.92	0.687		114,115	-17.26	0.830
	176-185	-16.95	0.694		194-197	-16.92	0.686		116,117	-17.27	0.830
	186-188	-16.96	0.694		198-200	-16.92	0.685		118	-17.29	0.834
82	93-95	-17.14	0.845	87	102-106	-17.20	0.845		$(119\text{-}126)^*$	-17.16	0.751
	$(96\text{-}106)^*$	-17.11	0.786		107-109	-17.23	0.845		$(127\text{-}148)^*$	-17.05	0.700
	$(107\text{-}133)^*$	-17.02	0.716		110	-17.24	0.845		149-154,172-176	-17.06	0.702

Continued 6 .... Table 1

Z	N	$\alpha(0)$	a_a	Z	N	$\alpha(0)$	a_a	Z	N	$\alpha(0)$	a_a
90	155-171	-17.06	0.703	93	152-155	-17.09	0.701	96	132,133	-17.34	0.803
	177-181	-17.07	0.703		156-186	-17.10	0.705		134,135	-17.36	0.803
	182-189	-16.92	0.685		187-189	-17.00	0.691		136	-17.37	0.800
	190-192	-16.92	0.684		190-192	-17.00	0.690		$(137,154\text{-}156)^*$	-17.15	0.707
	193-196	-16.92	0.683		193-195	-17.00	0.689		$(138\text{-}153)^*$	-17.15	0.705
	197-202	-16.92	0.682		196-199	-17.00	0.688		157-186	-17.15	0.709
	203-205	-16.92	0.681		200-203	-17.00	0.687		187-189	-17.02	0.691
	206-209	-16.92	0.680		204-206	-17.00	0.686		190,191	-17.02	0.690
91	109-115	-17.26	0.830		207-212	-17.00	0.685		192-194	-17.02	0.689
	116,117	-17.27	0.830		213-215	-17.00	0.684		195-197	-17.02	0.688
	118,119	-17.29	0.834	94	115-119	-17.26	0.801		198-200	-17.02	0.687
	120	-17.30	0.832		120-123	-17.27	0.801		201-204	-17.02	0.686
	$(121\text{-}129)^*$	-17.17	0.751		124-127	-17.28	0.800		205-208	-17.02	0.685
	$(130\text{-}149)^*$	-17.06	0.699		128,129	-17.30	0.803		209-217	-17.02	0.684
	150-155,177-187	-17.07	0.702		130,131	-17.31	0.800		218-222	-17.02	0.683
	156-166,169-176	-17.07	0.703		132,133	-17.33	0.800	97	121-127	-17.29	0.800
	167,168	-17.07	0.704		$(134\text{-}153)^*$	-17.11	0.701		128,129	-17.30	0.800
	188-190	-16.93	0.685		154-158	-17.10	0.701		130,131	-17.32	0.801
	191-193	-16.93	0.684		159-187	-17.11	0.705		132,133	-17.34	0.802
	194-196	-16.93	0.683		188,189	-17.00	0.690		134,135	-17.36	0.803
	197-203	-16.93	0.682		190-192	-17.00	0.689		136,137	-17.38	0.803
	204-209	-16.93	0.681		193-195	-17.00	0.688		$(138,155\text{-}157)^*$	-17.16	0.707
	210,211	-16.93	0.680		196-199	-17.00	0.687		$(139\text{-}154)^*$	-17.17	0.708
92	111-117	-17.27	0.827		200-203	-17.00	0.686		158-166	-17.16	0.709
	118-121	-17.28	0.820		204-207	-17.00	0.685		167-186	-17.15	0.709
	122,123	-17.31	0.830		208-215	-17.00	0.684		187-189	-17.03	0.691
	124	-17.31	0.820		216-218	-17.00	0.683		190-192	-17.03	0.690
	$(125\text{-}128,134\text{-}137)^*$	-17.09	0.704	95	117-123	-17.27	0.800		193,194	-17.03	0.689
	$(129\text{-}133)^*$	-17.09	0.707		124-127	-17.28	0.800		195-197	-17.03	0.688
	$(138\text{-}150)^*$	-17.08	0.700		128,129	-17.29	0.800		198-201	-17.03	0.687
	151-154	-17.08	0.701		130,131	-17.31	0.800		202-205	-17.03	0.686
	155-185	-17.08	0.703		132,133	-17.33	0.800		206-210	-17.03	0.685
	186-189	-16.99	0.691		134,135	-17.35	0.800		211-220	-17.03	0.684
	190,191	-16.99	0.690		$(136\text{-}150)^*$	-17.12	0.700		221-224	-17.04	0.684
	192-194	-16.99	0.689		$(151\text{-}154)^*$	-17.13	0.704	98	123-127	-17.30	0.800
	195-197	-16.99	0.688		155-185	-17.14	0.709		128,129	-17.31	0.800
	198-201	-16.99	0.687		186-188	-17.01	0.691		130,131	-17.33	0.803
	202-205	-16.99	0.686		189,190	-17.01	0.690		132,133	-17.35	0.805
	206-209,212	-16.99	0.685		191-193	-17.01	0.689		134,135	-17.37	0.806
	210,211,213	-16.99	0.684		194-197	-17.01	0.688		136,137	-17.39	0.807
93	113-118	-17.25	0.800		198-200	-17.01	0.687		138	-17.38	0.800
	119-123	-17.26	0.800		201-204	-17.01	0.686		$(139\text{-}153)^*$	-17.18	0.707
	124-126	-17.27	0.800		205-208	-17.01	0.685		$(154\text{-}158)^*$	-17.18	0.709
	127	-17.28	0.800		209-217	-17.01	0.684		159-165	-17.17	0.709
	128,129	-17.29	0.800		218-220	-17.01	0.683		166-187	-17.17	0.710
	130,131	-17.31	0.800	96	119-124	-17.28	0.800		188-190	-17.05	0.692
	$(132\text{-}140,146\text{-}151)^*$	-17.09	0.700		125-129	-17.29	0.800		191-193	-17.05	0.691
	$(141\text{-}145)^*$	-17.10	0.701		130,131	-17.32	0.801		194,195	-17.05	0.690

Continued 7 .... Table 1

Z	N	$\alpha(0)$	a_a	Z	N	$\alpha(0)$	a_a	Z	N	$\alpha(0)$	a_a
98	196-198	-17.05	0.689	101	134,135	-17.37	0.801	103	171-188	-17.24	0.717
	199-201	-17.05	0.688		136,137	-17.39	0.803		189-190	-17.08	0.690
	202-205	-17.04	0.686		138,139	-17.40	0.801		191-193	-17.08	0.689
	206-211	-17.04	0.685		140,141	-17.42	0.802		194-196	-17.08	0.688
	212-227	-17.04	0.684		142,143	-17.44	0.803		197-199	-17.08	0.687
99	125-129	-17.31	0.800		$(144\text{-}155)^*$	-17.22	0.710		200-205	-17.08	0.686
	130,131	-17.33	0.800		$(156\text{-}161)^*$	-17.22	0.712		206-215,227	-17.08	0.685
	132	-17.34	0.800		162-166	-17.21	0.711		216-226	-17.08	0.684
	133,134	-17.35	0.800		167-186	-17.21	0.714		228-236	-17.08	0.684
	135,136	-17.37	0.801		187-189	-17.07	0.692	104	134,135	-17.39	0.804
	137,138	-17.39	0.802		190,191	-17.07	0.691		136,137	-17.40	0.804
	139,140	-17.42	0.807		192,193	-17.07	0.690		138,139	-17.41	0.801
	$(141\text{-}154)^*$	-17.19	0.707		194-196	-17.07	0.689		140,141	-17.43	0.804
	$(155\text{-}159)^*$	-17.19	0.709		197-199	-17.07	0.688		142,143	-17.44	0.801
	160-166	-17.18	0.709		200-203	-17.07	0.687		144,145	-17.46	0.804
	167-180	-17.18	0.711		204-211	-17.07	0.686		146,147	-17.47	0.801
	181-187	-17.05	0.692		212-220,227-233	-17.07	0.685		148	-17.48	0.801
	188-191	-17.05	0.691		221-226	-17.07	0.684		$(149\text{-}164)^*$	-17.30	0.727
	192,193	-17.05	0.690	102	130,131	-17.35	0.802		165-167	-17.26	0.716
	194,195	-17.05	0.689		132,133	-17.36	0.800		168-187	-17.26	0.719
	196-199	-17.05	0.688		134,135	-17.38	0.802		188-191	-17.09	0.690
	200-202	-17.05	0.687		136,137	-17.39	0.800		192,193	-17.09	0.689
	203-207	-17.05	0.686		138,139	-17.40	0.800		194-196	-17.09	0.688
	208-216,227	-17.05	0.685		140,141	-17.42	0.800		197-199	-17.09	0.687
	217-226,228,229	-17.05	0.684		142,143	-17.44	0.802		200-205	-17.09	0.686
100	126-129	-17.32	0.802		144,145	-17.45	0.800		206-216,227	-17.09	0.685
	130,131	-17.34	0.802		$(146\text{-}162)^*$	-17.27	0.723		217-226	-17.09	0.684
	132,133	-17.35	0.802		163-167	-17.22	0.711		228-235	-17.09	0.684
	134,135	-17.37	0.802		168-182	-17.22	0.714	105	136,137	-17.40	0.800
	136,137	-17.39	0.804		183-188	-17.07	0.691		138,139	-17.41	0.800
	138,139	-17.41	0.805		189,190	-17.07	0.690		140,141	-17.43	0.802
	140,141	-17.43	0.807		191-193	-17.07	0.689		142,143	-17.44	0.800
	$(142\text{-}154)^*$	-17.21	0.710		194,195	-17.07	0.688		144,145	-17.45	0.800
	$(155\text{-}160)^*$	-17.22	0.714		196-199	-17.07	0.687		146,147	-17.47	0.801
	161-166	-17.18	0.706		200-203	-17.07	0.686		148,149	-17.49	0.803
	167-170	-17.18	0.709		204-212	-17.07	0.685		$(150\text{-}165)^*$	-17.30	0.725
	171-186	-17.18	0.710		213-236	-17.07	0.684		166,167	-17.27	0.717
	187-189	-17.05	0.690	103	132,133	-17.37	0.803		168-186	-17.27	0.720
	190-192	-17.05	0.689		134,135	-17.38	0.803		187-191	-17.10	0.690
	193-195	-17.05	0.688		136,137	-17.39	0.800		192-194	-17.10	0.689
	196-198	-17.05	0.687		138,139	-17.41	0.803		195-197	-17.10	0.688
	199-201	-17.05	0.686		140,141	-17.42	0.800		198-201	-17.10	0.687
	202-207	-17.05	0.685		142,143	-17.44	0.803		202-208	-17.10	0.686
	208-218,227	-17.05	0.684		144,145	-17.45	0.800		209-218,227-234	-17.10	0.685
	219-226,228-231	-17.07	0.685		146,147	-17.47	0.802		219-226	-17.10	0.684
101	128,129	-17.33	0.800		$(148\text{-}163)^*$	-17.27	0.721	106	138,139	-17.42	0.800
	130,131	-17.34	0.800		164-166	-17.25	0.716		140,141	-17.43	0.800
	132,133	-17.36	0.803		167-170	-17.24	0.716		142,143	-17.44	0.800

Continued 8 .... Table 1

Z	N	$\alpha(0)$	a_a	Z	N	$\alpha(0)$	a_a	Z	N	$\alpha(0)$	a_a
106	144,145	-17.46	0.802	109	150,151	-17.51	0.803	112	214-224	-17.17	0.687
	146,147	-17.47	0.800		152,153	-17.52	0.803		225-227	-17.17	0.686
	148,149	-17.49	0.802		154	-17.53	0.803	113	153-164	-17.38	0.728
	150,151	-17.50	0.800		155	-17.34	0.724		165-169	-17.37	0.727
	$(152\text{-}165)^*$	-17.33	0.731		$(156\text{-}162)^*$	-17.34	0.727		$(170\text{-}174)^*$	-17.35	0.724
	$(166\text{-}167)^*$	-17.33	0.731		$(163\text{-}170)^*$	-17.33	0.726		175-188	-17.37	0.729
	168-186	-17.29	0.722		171-183	-17.33	0.726		189-197	-17.18	0.690
	187-191	-17.11	0.690		184-194	-17.14	0.690		198-201	-17.18	0.689
	192-194	-17.11	0.689		195-197	-17.14	0.689		202-221	-17.18	0.688
	195-197	-17.11	0.688		198-200	-17.14	0.688		222-226	-17.18	0.687
	198-201	-17.11	0.687		201-209	-17.14	0.687	114	155-170	-17.39	0.730
	202-209	-17.11	0.686		210-218,222-227	-17.14	0.686		$(171\text{-}175)^*$	-17.35	0.722
	210-233	-17.11	0.685		219-221	-17.15	0.688		176-182,188-190	-17.38	0.729
107	140,141	-17.43	0.800		228-230	-17.14	0.685		183-187	-17.38	0.730
	142,143	-17.45	0.802	110	146,147	-17.48	0.800		191-197	-17.19	0.690
	144,145	-17.46	0.800		148,149	-17.49	0.800		198-201	-17.19	0.689
	146,147	-17.47	0.800		150,151	-17.50	0.800		202-221	-17.19	0.688
	148,149	-17.49	0.802		152,153	-17.52	0.802		222-225	-17.19	0.687
	150,151	-17.50	0.800		154-156	-17.35	0.725	115	157-171	-17.40	0.731
	152	-17.51	0.800		$(157\text{-}164)^*$	-17.35	0.728		$(172\text{-}176)^*$	-17.35	0.720
	$(153\text{-}168)^*$	-17.33	0.729		$(165\text{-}172)^*$	-17.34	0.727		177-181	-17.39	0.730
	169	-17.30	0.721		173-187	-17.34	0.727		182-189	-17.39	0.731
	170-182	-17.30	0.723		188-194	-17.15	0.690		190-197	-17.20	0.690
	183-192	-17.12	0.690		195-197	-17.15	0.689		198-215	-17.20	0.689
	193-195	-17.12	0.689		198-201	-17.15	0.688		216-224	-17.20	0.688
	196-198	-17.12	0.688		202-211,218-223	-17.15	0.687	116	159-167	-17.41	0.731
	199-203	-17.12	0.687		212-217,224-227	-17.15	0.686		168-172	-17.41	0.733
	204-211,226	-17.12	0.686		228,229	-17.15	0.685		$(173\text{-}176)^*$	-17.42	0.740
	212-225,227-232	-17.12	0.685	111	148,149	-17.49	0.800		177-179	-17.41	0.733
108	142,143	-17.45	0.802		150,151	-17.51	0.804		180-189	-17.40	0.732
	144,145	-17.46	0.800		152	-17.51	0.800		190-197	-17.21	0.690
	146,147	-17.48	0.802		153-160	-17.36	0.726		198-219	-17.21	0.689
	148,149	-17.49	0.802		$(161\text{-}164)^*$	-17.37	0.733		220-223	-17.21	0.688
	150,151	-17.50	0.800		$(165\text{-}172)^*$	-17.35	0.728	117	161-171	-17.42	0.733
	152,153	-17.52	0.802		173-183	-17.35	0.727		172,173,176	-17.42	0.735
	154	-17.53	0.802		184-188	-17.16	0.689		$(174,175)^*$	-17.42	0.739
	$(155\text{-}169)^*$	-17.33	0.727		189-197	-17.16	0.690		177-181	-17.41	0.733
	170-183	-17.32	0.725		198-207	-17.16	0.688		182-189	-17.41	0.734
	184-193	-17.13	0.690		208-225	-17.16	0.687		190-198	-17.22	0.690
	194-195	-17.13	0.689		226-228	-17.16	0.686		199-222	-17.22	0.689
	196-199	-17.13	0.688	112	150,151	-17.51	0.802	118	163-174,176	-17.44	0.739
	200-203	-17.13	0.687		152-164	-17.37	0.726		$(175)^*$	-17.42	0.739
	204-218,220-223,225-226	-17.13	0.686		$(165\text{-}173)^*$	-17.35	0.726		177-181	-17.43	0.737
	219,224,227-231	-17.13	0.685		174-188	-17.36	0.728		182-188	-17.42	0.736
109	144,145	-17.47	0.803		189-195	-17.17	0.690		189-194	-17.23	0.690
	146,147	-17.48	0.803		196-199	-17.17	0.689		195-197	-17.23	0.687
	148,149	-17.49	0.802		200-213	-17.17	0.688		198-221	-17.23	0.689